typically, the leader can improve on this by coordinating production [otherwise known as exercising market power]. (Lewis, p. 1092,)

Preemption may be either complete or partial. Under complete preemption, the monopolist is able profitably to acquire all alternative supply sources. Under partial preemption, the monopolist is only able profitably to acquire some of the alternative supply sources. Lewis showed that complete preemption of a scarce resource may not always be profitable, but that partial preemption is always profitable.[24] Both complete and partial preemption is bad -- economic welfare is reduced.[25]

Thus, the economics literature on preemption establishes that complete preemption by a dominant firm of all alternatives for necessary scarce resources to challenge the dominant firm may be profitable, but even where complete preemption is not profitable, partial preemption will always be in the monopolist's economic interest.

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[24]Complete preemption is sometimes unprofitable because of a free-rider effect. The dominant firm bears all of the necessary output restriction to exercise market power. With many alternative sources of competition, complete preemption becomes unprofitable because with each increment of the scarce resource controlled by the dominant firm, the value of the remaining units of the resource to others increases. Increased control of the scarce resource by the dominant firm leads to an increase in market price, which in turn leads to an increased valuation of the remaining uncontrolled capacity by the fringe players. Lewis shows that it is always profitable for a dominant firm with market power to preempt the first alternative source of supply, but it may not be profitable (because of the free-rider effect described above) for the dominant firm to completely preempt all alternatives. (pp. 1095-6.) The major economic factors in determining the extent of preemption are the number of alternative sources, the capacity of the alternative sources relative to the installed capacity of the incumbent, and the market demand elasticity. The higher the market demand elasticity, the greater the cost (in terms of an output restriction) that the incumbent must bear to exercise market power.

[25]Ibid., p. 1099.

2. POTENTIAL EFFECTS OF A BIDDING LIMITATION ON AUCTION REVENUE.

One should not assume that the government's revenues from any auction of the relevant spectrum would be lower if incumbent Little LEO suppliers were not allowed to bid, since adding incumbents to the auction will not necessarily increase the number of bidders. Auction participation requires potential bidders to place at risk a significant investment. These expenditures include the costs of research to estimate demand, the costs of reaching partnering agreements, the costs of establishing detailed build-out plans, the costs of raising capital from variety of sources, and the cost of the legal and economic analysis necessary to receive regulatory approval.

Companies will not incur such up-front costs to participate in an effort that they are certain to lose, nor can sources of venture capital be expected for such efforts. Thus, if other participants believe that the incumbent monopolist will prevail in bidding (which is just what the preemption theory says will happen if everyone has full information), then alternative bidders will not bid. This is especially true in an English auction such as the FCC would be likely to run. In such an auction, each bidder can submit a sequence of bids, and knows what the prevailing high bid is at all times. There is no chance the monopolist will make a mistake and accidentally be outbid by somebody else.[26] Thus, auction revenues could fall if a single incumbent with market power were allowed to bid. All competitive bidders have strong incentives not to spend the money necessary to prepare a bid, knowing ultimately they will be outbid by someone who, because of market power, values the license more highly. The price of spectrum will be determined, in part, by the number of bidders. Adding incumbent Little LEO licensees as bidders will not increase the total number of bidders if other participants drop out.

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[26]This possibility would exist in a sealed bid auction.

SECTION IX: *AN AUCTION COULD BE PROBLEMATIC IN THIS INSTANCE, EVEN IF INCUMBENTS ARE EXCLUDED.*

Difficulties can arise with auctions when, as in the case with spectrum, the value of pieces are interdependent, and where (as a result) opportunistic holdout is possible. Thus, if an auction is held, any auction should not just exclude incumbents, but should also (1) allow bidding on units and groups, and (2) exclude those not planning on producing. This may be difficult. If so, a better approach may be to not have an auction.

A decision by the Commission to license the available spectrum rather than conduct an auction has ancillary implications. In particular, if the spectrum is assigned to second round applicants it seems unlikely that the new license holders will be allowed to redistribute the spectrum among each other through sales and exchanges after the award. As discussed below in Section XI, to allow such sales would not only allow windfall gains to applicants, but would also encourage rent-seeking applicants whose participation could either void the procompetitive effects of excluding incumbents from this round, or increase the cost to true entrants of building an efficiently sized and configured system. One implication of this observation is that it will be essential for the Commission to configure and assign this spectrum efficiently, since post-license adjustments through market mechanisms will be impossible or only occur at high transactions costs. We thus turn to the issue of how the spectrum should be organized before assignment.

SECTION X: THE SPECTRUM SHOULD BE REORGANIZED BEFORE THE FCC ASSIGNS LICENSES.

As discussed above in Section VI, *Table 4: HHI Analysis* presents individual system capacities, market shares and the resulting HHI level under different assumptions as to licensing outcomes (the four rows in Table 4) and the role and viability of VITA and GE Starsys, respectively (the four columns in Table 4). Row 3 of Table 4 presents Leo One USA's estimate of the individual system capacity levels and capacity shares, and the resulting HHI level, if licenses are awarded for Systems 1, 2, and 3, as proposed in the Notice, while row 4 presents Leo One USA's estimate of the individual system capacity levels and capacity shares, and the resulting HHI level, if licenses are awarded for Systems A and B, as proposed by Leo One USA.

In contrasting the two proposals, four points stand out.

First, the Leo One USA proposal to create System A and System B results in a much more efficient use of the available spectrum. Total capacity is 3.13 "ORBCOMM equivalent units" versus 2.36 units under the NPRM proposal. As compared with existing licensed systems, there would be a 139% increase in capacity under the Leo One USA proposal, as opposed to an 80% increase in total capacity under the NPRM proposal. The Leo One USA proposal would result in a 33% increase in capacity over that available under the NPRM proposal. As in any market, a larger total capacity (holding constant the distribution of that total capacity among suppliers, as measured, for example, by the HHI) can be expected to result in lower costs (either financial costs or opportunity costs or both) to providers, greater output, lower prices and larger gains to consumers.

Second, the comparative advantage of Leo One USA's proposal improves if, as is likely, VITA operates in specialized not-for-profit markets and/or GE Starsys fails to launch its system. *Table 7: Percentage Increases in Total Capacity under NPRM Proposal and Leo One Proposal* presents the percentage increase in total capacity under the four alternative scenarios with respect to VITA and GE Starsys. As Table 7 shows, the 80% increase in capacity when incumbents are .

TABLE 7: PERCENTAGE INCREASES IN TOTAL CAPACITY UNDER NPRM PROPOSAL AND LITTLE LEO PROPOSAL.

	ORBCOMM, GE Starsys and VITA each fully deploy	VITA operates in specialized not-for-profit market	GE Starsys fails to launch its system	Neither VITA nor GE Starsys participate in the market
1. Percent increase in total capacity from NPRM proposal over today's environment	80	85	99	106
2. Percent increase in total capacity from Leo One USA's proposal over today's environment	139	145	171	182
3. Percent increase in total capacity from Leo One USA's proposal over NPRM proposal	33	33	36	37
4. Difference in percent increase, Leo One USA proposal versus NPRM (row 2. - row 1.)	59	60	72	76

excluded under the NPRM proposal rises to 106% when neither VITA nor GE Starsys participate in the market, while the 139% increase in capacity when incumbents are excluded rises to 182%

when neither VITA nor GE Starsys participate in the market. The advantage of the Leo One USA proposal thus increases from a 59 percentage point increase in capacity to a 76 percentage point increase in capacity if neither VITA nor GE Starsys are expected to participate in the market

Third, under the Leo One USA proposal, the (greater) capacity is assigned so as to produce a more competitive market structure. Although the number of suppliers is smaller than in the NPRM proposal (five rather than six), capacity is more evenly distributed among those five suppliers. This more equal distribution more than offsets the effect on the HHI of a smaller number of suppliers[27], resulting in a significantly lower HHI under the Leo One USA proposal than under the NPRM.

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[27] The HHI can be decomposed into a "number of suppliers" component and a "variance" component (See John E. Kwoka, Jr, "The Herfindahl Index in Theory and Practice," 30 *Antitrust Bulletin* 915-948 (Winter 1885). Specifically:

$$HHI = 10{,}000 / N + 10{,}000\ Var / N$$

where N is the number of firms and Var is the square of the coefficient of variation in firm size. Thus the HHI under the NPRM proposal in Column 1 of Table 4 is:

$$HHI_{3,1} = 10{,}000 / 6 + 10{,}000\ (0.905) / 6$$
$$= 1667 + 1508$$
$$= 3175$$

while the HHI under the Leo One USA proposal in Column 1 is:

$$HHI4,1 = 10{,}000/5 + 10{,}000\ (0.3920)/5$$
$$= 2{,}000 + 784$$
$$= 2784$$

The 724 point fall in the variance component of the HHI (from 1508 to 784) when going from the NPRM to the Leo One USA proposal is greater than the 333 point increase in the numbers component of the HHI (from 1667 to 2000), resulting in a net fall in the HHI under the Leo One USA proposal by 391 points.

TABLE 8: REDUCTIONS IN HHI UNDER NPRM PROPOSAL AND LEO ONE PROPOSAL UNDER ALTERNATIVE VITA AND GE STARSYS SCENARIOS.

	ORBCOMM. GE Starsys and VITA each fully deploy	VITA operates in specialized not-for-profit market	GE Starsys fails to launch its system	Neither VITA nor GE Starsys participate in the market
1. Decrease in the HHI under NPRM proposal from today's environment (and as % of current)	3064 = 49%	3472 = 51%	5149 = 57%	5961 = 60%
2. Decrease in the HHI under Leo One USA's proposal from today's environment (and as % of current)	3455 = 55%	3915 = 58%	5767 = 64%	6660 = 67%
3. Additional decrease in the HHI under Leo One USA's proposals compared to the NPRM proposal (and as % of 1.)	391 = 13%	443 = 13%	618 = 12%	699 = 12%

Fourth, as was the case for total capacity, the effect on the competitiveness of the market (as measured by the HHI) from excluding incumbent suppliers from the licensing (or auction) increases with the probability that VITA and/or GE Starsys will not be effective competitors in the relevant markets. As *Table 8: Reductions in HHI under NPRM Proposal and Leo One Proposal under Alternative VITA and GE Starsys Scenarios* shows, if VITA operates in specialized not-for-profit markets and GE Starsys fails to launch, the percentage decrease in the HHI achieved by excluding incumbent suppliers from the allocation (or auction) -- a proxy for

the percentage decrease in prices -- goes from a 49% decrease to a 60% decrease under the NPRM allocation, and from a 55% decrease to 67% decrease under the Leo One USA proposal.[28]

As these calculations show, it is important not simply to count the number of suppliers in a market in determining the likely competitiveness of the market or the welfare of consumers. The effect on the prices paid by consumers from a larger number of suppliers can be swamped by the effects of larger total capacity, or by the effects of a more even distribution of that capacity or -- as in this case -- both.

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[28] In an analysis corresponding to that in the preceding footnote, we can disaggregate the HHI under the NPRM and Leo One USA proposals for the case where neither VITA nor GE Starsys is in the market. Under these assumptions, the HHI under the NPRM proposal in Column 4 of Table 4 is:

$$HHI_{3,4} = 10,000 / 4 + 10,000\ (0.8348) / 4$$
$$= 2,500 + 2,087$$
$$= 4,587$$

While the HHI under the Leo One USA proposal in Column 4 of Table 4 is:

$$HHI_{4,4} = 10,000 / 3 + 10,000\ (0.0021) / 3$$
$$= 3,333 + 7$$
$$= 3,340$$

The fall in the variance component of the HHI is now 2080 points (from 2087 to 7). Even though the 833 point increase in the numbers component of the HHI (from 2500 to 3333) is also larger than in the scenario where both VITA and GE Starsys participate in the market, net fall in the HHI by 1,247 points under the Leo One USA proposal is much larger than in the scenario where both VITA and GE Starsys participate in the market.

SECTION X: PROCOMPETITIVE POST-LICENSING RESTRICTIONS

If reallocations of second-round-licensed spectrum through a market were costless, the Commission's initial assignments would have no effect on the ultimate distribution of that spectrum.[29] If, as argued above, an auction by the Commission of these spectrum rights would lead to their being acquired directly by the incumbent monopolist or duopolists, then it will also be the case that, absent significant private transaction costs to reallocate that spectrum through the market, the incumbent monopolist or duopolist will rapidly acquire that spectrum through a post-licensing market transaction. In other words, if the Commission simply gives spectrum away with no restrictions on what the licensees do with that spectrum, we can expect a number of firms or individuals to attempt to induce the Commission to grant them spectrum which they would then turn around and sell to the highest bidder, which we would predict to be the incumbent monopolist.

Restrictions on post-licensing resale are thus essential to inducing actual entry and the resulting benefits to consumers. Those restrictions, however, must go beyond the normal restrictions under the antitrust laws. It is not enough, for example, for the Commission to prohibit the transfer of a second round license to a first round licensee if such a transfer would violate the antitrust laws or would be inconsistent with the *Guidelines*. Given the size of the fixed costs involved in a Little LEO entry, and the risks involved, it would hardly be surprising if one or more -- or even all -- second round licensees could make a convincing case that they were not, or were no longer, actual potential entrants. Such a showing would be particularly easy if the

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[29] This could be regarded as a partial version of the Coase theorem (Ronald H. Coase, "The Problem of Social Cost", *Journal of Law and Economics* 3: 1-44, 1960), which asserts that the optimal allocation of resources can always be achieved through market forces, irrespective of legal liability assignment, if information is perfect and transactions are costless.

amount or quality of the spectrum assigned to that licensee were insufficient for entry by that licensee to be profitable. The sale of their capacity to the incumbent monopolist would then be acceptable under the *Guidelines,* since standard antitrust analysis would have to take the Commission's initial allocation as a *fait accompli.* Knowing this to be the case, such a limited restriction on post-licensing market transfer would not inhibit the attempt by potential licensees to obtain or acquire spectrum, of any quantity or in any configuration, however inefficient, which they could then resell to the incumbent monopolist. Potential licensees could even knowingly request that the FCC issue it spectrum that by itself cannot support a commercially viable operation, in the hopes of reselling the spectrum to an incumbent monopolist. Or, in even more anticompetitive scenario, potential licensees could request that the FCC issue it spectrum that could not support a commercially viable operation but which would be critical to the commercial viability of a true entrant, in the hopes of reselling that spectrum to a true entrant, thus imposing, in effect, a tax on entry.

The mere possibility of post-licensing resale can thus corrupt any initial mechanism for distributing spectrum, whether through an auction or through direct assignment. Since the Commission cannot require that every licensee commit to full-scale entry regardless of future conditions or events, it is thus critical that certain post-licensing resales, transfers or transactions between private parties be restricted.[30] Furthermore, the simple holding of unused spectrum by licensees that do not enter imposes real social costs, including higher costs to consumers. Thus, unless the Commission wants to be in a position where it must buy back unused spectrum from

[30] As should be clear, the potentially anticompetitive transactions are any purchases by the incumbent monopoly or dominant supplier (since this facilitates continued monopolization) and purchases by licensees that are viable potential entrants (since, like paying ransom, this just encourages inefficient competition for licenses and increases the cost of entry). On the other hand, neither monopolization nor holdup is affected by allowing the monopoly or dominant supplier to sell spectrum, or actual entrants to buy, sell or exchange spectrum.

licensees that do not undertake full-scale entry as Little LEO suppliers, it is important that licenses have a "use it or lose it" provision with a fairly tight time frame, under which unused spectrum reverts to the Commission.[31] Such a provision is necessary unless spectrum is distributed through an auction to a competitive industry.

The alternative to this proposal is to regulate such transactions via antitrust. But the proposal here has a distinct advantage. Under antitrust, the sale of spectrum to a firm with market power would not generally be allowed if some other entity is willing to purchase the spectrum. Under antitrust, the market-based allocation of resources is generally preferred, except where one suspects the transaction is affected by market power. But returning unused spectrum to the Commission does not require the Commission to forego a market-based reallocation of the spectrum to another owner via an auction, if that is what the Commission wants to do. Moreover, returning unused spectrum to the Commission has a potentially important advantage over allowing the first-round spectrum-holder to resell it. The Commission, faced with the evidence that the initial allocation could not support a commercially viable operation, can redefine the spectrum rights, or combine the spectrum with another, as yet unallocated block, before the spectrum is reassigned (possibly by auction) to a new owner. In that case, the spectrum will be used more efficiently, and consumers will derive greater ultimate benefits, if the reorganization and reallocation of spectrum is done within the Commission rather than through a market.

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[31] While such a provision should clearly apply to new licensees, application of "use it or lose it" provisions to suppliers who have already entered is undesirable, except possibly to an incumbent monopolist or dominant supplier. While such provisions may inhibit "warehousing" by a monopolist or by a firm or firms with market power, it may also induce inefficiently premature use and block the efficient expansion path over time.

Frederick R. Warren-Boulton

Subscribed and sworn to before me this 20th day of December, 1996.

C. A. Norris
Notary Public District of Columbia
My Commission Expires June 30, 2001

Notary Public

My Commission expires 6/30/2001

TABLE 1: MARKETS AND SUPPLIERS

TRACKING

			Satellite Systems								Terrestrial Voice & Data							Terrestrial Data								
				Little LEO			Big Leo		Geo-synch																	
Tracking	***Coverage***	***Outages***	Leo One USA	Orbcomm	Starsys	VITA	Big Leo Systems	Inmarsat	AMSC (Skycell)	Omnitracs	Highwaymaster	VHF Radio Systems/WaterComm	Cellular	Broadband PCS	SMR	Geotek	NexTel	Ram Mobile Data	Ardis	CellNet	Metricom	CDPD	Cellemetry	Pinpoint Comm.	Nexus Tele.	Narrowband PCS
Truck dispatch and monitoring	Global	< 5 minutes	l				m/h	H																		
		> 5 min. & < 30 mi	*				*	*																		
		> 30 min. & < 3 hr.	*	L	l		*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 5 minutes	l				m/h	H	H	H																
		> 5 min. & < 30 mi	*				*	*	*	*																
		> 30 min. & < 3 hr.	*	L	l		*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 5 minutes	l				m/h	H	H	H	H		L	L			M	M	M							
		> 5 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min. & < 3 hr.	*	L	l		*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 5 minutes	l				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		l		l
		> 5 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min. & < 3 hr.	*	L	l		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
Maritime - commercial shipping	Global	< 5 minutes	l				m/h	H																		
		> 5 min. & < 30 mi	*				*	*																		
		> 30 min. & < 3 hr.	*	L	l		*	*	Hc	Hc		Mc														
	Nationwide: Coastal & Waterways	< 5 minutes	l				m/h	H	H	H		M														
		> 5 min. & < 30 mi	*				*	*	*	*		*														
		> 30 min. & < 3 hr.	*	L	l		*	*	*	*		*														
Maritime - recreational	Global	< 5 minutes	l				m/h	H																		
		> 5 min. & < 30 mi	*				*	*																		
		> 30 min. & < 3 hr.	*	L	l		*	*	Hc	Hc		Mc														
	Nationwide: Coastal & Waterways	< 5 minutes	l				m/h	H	H	H		M														
		> 5 min. & < 30 mi	*				*	*	*	*		*														
		> 30 min. & < 3 hr.	*	L	l		*	*	*	*		*														
Tracking - standard containers	Global	< 5 minutes	l				m/h	H																		
		> 5 min. & < 30 mi	*				*	*																		
		> 30 min. & < 3 hr.	*	L	l		*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 5 minutes	l				m/h	H	H	H																
		> 5 min. & < 30 mi	*				*	*	*	*																
		> 30 min. & < 3 hr.	*	L	l		*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 5 minutes	l				m/h	H	H	H	H		L	L			M	M	M							
		> 5 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min. & < 3 hr.	*	L	l		*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 5 minutes	l				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		l		l
		> 5 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min. & < 3 hr.	*	L	l		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*

TABLE 1: MARKETS AND SUPPLIERS

TRACKING

Tracking	Coverage	Outages	Satellite Systems: Little LEO: Leo One USA	Little LEO: Orbcomm	Little LEO: Starsys	Little LEO: VITA	Big Leo: Big Leo Systems	Geo-synch: Inmarsat	Geo-synch: AMSC (Skycell)	Geo-synch: Omnitracs	Terrestrial Voice & Data: Highwaymaster	Terrestrial Voice & Data: VHF Radio Systems/WaterComm	Terrestrial Voice & Data: Cellular	Terrestrial Voice & Data: Broadband PCS	Terrestrial Voice & Data: SMR	Terrestrial Voice & Data: Geotek	Terrestrial Voice & Data: NexTel	Terrestrial Data: Ram Mobile Data	Terrestrial Data: Ardis	Terrestrial Data: CellNet	Terrestrial Data: Metricom	Terrestrial Data: CDPD	Terrestrial Data: Cellemetry	Terrestrial Data: Pinpoint Comm.	Terrestrial Data: Nexus Tele.	Terrestrial Data: Narrowband PCS
Tracking - Refridgerated & hazardous material containers	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min. & < 3 hr.	*	L	I		*	*	Hc	Hc																
	Nationwide: Ubiquitious	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min. & < 3 hr.	*	L	I		*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitious	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min. & < 3 hr.	*	L	I		*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min. & < 3 hr.	*	L	I		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*

TABLE 1: MARKETS AND SUPPLIERS

MONITORING

Monitoring	Coverage	Outages	Satellite Systems: Little LEO: Leo One USA	Little LEO: Orbcomm	Little LEO: Starsys	Little LEO: VITA	Big Leo: Big Leo Systems	Geo-synch: Inmarsat	Geo-synch: AMSC (Skyoail)	Geo-synch: Omnitracs	Terrestrial Voice & Data: Highwaymaster	Terrestrial Voice & Data: VHF Radio Systems/WaterComm	Terrestrial Voice & Data: Cellular	Terrestrial Voice & Data: Broadband PCS	Terrestrial Voice & Data: SMR	Terrestrial Voice & Data: Geotek	Terrestrial Voice & Data: NexTel	Terrestrial Data: Ram Mobile Data	Terrestrial Data: Ardis	Terrestrial Data: CellNet	Terrestrial Data: Metricom	Terrestrial Data: CDPD	Terrestrial Data: Cellemetry	Terrestrial Data: Pinpoint Comm.	Terrestrial Data: Nexus Tele.	Terrestrial Data: Narrowband PCS
Oil and Gas Wells	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min. & < 3 hrs	*	L	I		*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min. & < 3 hrs	*	L	I		*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min. & < 3 hrs	*	L	I		*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min. & < 3 hrs	*	L	I		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
Pipeline Monitoring sites	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min. & < 3 hrs	*	L	I		*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min. & < 3 hrs	*	L	I		*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min. & < 3 hrs	*	L	I		*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min. & < 3 hrs	*	L	I		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
Utility Meters	Global	< 20 minutes	I				m/h	H																		
		> 20 min. & < 3 hrs	*	L	I		*	*																		
		> 3 hrs	*	*	*	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 20 minutes	I				m/h	H	H	H																
		> 20 min. & < 3 hrs	*	L	I		*	*	*	*																
		> 3 hrs	*	*	*	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 20 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 20 min. & < 3 hrs	*	L	I		*	*	*	*	*		*	*			*	*	*							
		> 3 hrs	*	*	*	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 20 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 20 min. & < 3 hrs	*	L	I		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 3 hrs	*	*	*	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*

TABLE 1: MARKETS AND SUPPLIERS MONITORING

Monitoring	Coverage	Outages	Satellite Systems: Little LEO: Leo One USA	Little LEO: Orbcomm	Little LEO: Starsys	Little LEO: VITA	Big Leo: Big Leo Systems	Big Leo: Inmarsat	Geo-synch: AMSC (Skycell)	Geo-synch: Omnitracs	Terrestrial Voice & Data: Highwaymaster	Terrestrial Voice & Data: VHF Radio Systems/WaterComm	Terrestrial Voice & Data: Cellular	Terrestrial Voice & Data: Broadband PCS	Terrestrial Voice & Data: SMR	Terrestrial Voice & Data: Geotek	Terrestrial Voice & Data: NexTel	Terrestrial Data: Ram Mobile Data	Terrestrial Data: Ardis	Terrestrial Data: CellNet	Terrestrial Data: Metricom	Terrestrial Data: CDPD	Terrestrial Data: Cellemetry	Terrestrial Data: Pinpoint Comm.	Terrestrial Data: Nexus Tele.	Terrestrial Data: Narrowband PCS
Irrigation system control points	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min. & < 3 hrs	*	L	I		*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min. & < 3 hrs	*	L	I		*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min. & < 3 hrs	*	L	I		*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min. & < 3 hrs	*	L	I		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
Vending Machines	Global	< 30 minutes	I				m	H																		
		> 30 min. & < 3 hr.	*	L	I		*	*																		
		> 3 hours	*	*	*	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 30 minutes	I				m	H	H	H																
		> 30 min. & < 3 hr.	*	L	I		*	*	*	*																
		> 3 hours	*	*	*	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 30 minutes	I				m	H	H	H	H		L	L			M	M	M							
		> 30 min. & < 3 hr.	*	L	I		*	*	*	*	*		*	*			*	*	*							
		> 3 hours	*	*	*	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 30 minutes	I				m	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 30 min. & < 3 hr.	*	L	I		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 3 hours	*	*	*	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*

TABLE 1: MARKETS AND SUPPLIERS

MONITORING

			Satellite Systems								Terrestrial Voice & Data							Terrestrial Data								
				Little LEO			Big Leo		Geo-synch																	
Monitoring	***Coverage***	***Outages***	Leo One USA	Orbcomm	Starsys	VITA	Big Leo Systems	Inmarsat	AMSC (Skycell)	Omnitracs	Highwaymaster	VHF Radio Systems/WaterComm	Cellular	Broadband PCS	SMR	Geotek	NexTel	Ram Mobile Data	Ardis	CellNet	Metricom	CDPD	Cellemetry	Pinpoint Comm.	Nexus Tele.	Narrowband PCS
Security system monitoring	Global	< 2 minutes	l				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min. & < 3 hrs	*	L	l		*	*	Hc	Hc																
	Nationwide: Ubiquitious	< 2 minutes	l				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min. & < 3 hrs	*	L	l		*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitious	< 2 minutes	l				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min. & < 3 hrs	*	L	l		*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		lc		lc
	Urban / Pockets of Coverage	< 2 minutes	l				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		l		l
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min. & < 3 hrs	*	L	l		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*

TABLE 1: MARKETS AND SUPPLIERS
EMERGENCY SERVICES

			Satellite Systems								Terrestrial Voice & Data							Terrestrial Data								
				Little LEO			Big Leo	Geo-synch																		
Emergency Services	***Coverage***	***Outages***	Leo One USA	Orbcomm	Starsys	VITA	Big Leo Systems	Inmarsat	AMSC (Skycell)	Omnitracs	Highwaymaster	VHF Radio Systems/WaterComm	Cellular	Broadband PCS	SMR	Geotek	NexTel	Ram Mobile Data	Ardis	CellNet	Metricom	CDPD	Cellemetry	Pinpoint Comm.	Nexus Tele.	Narrowband PCS
Emergency Road Service Subscribers	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 min.	*				*	*																		
		> 30 min.	*	L	I	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 min.	*				*	*	*	*																
		> 30 min.	*	L	I	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 min.	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 min.	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
New Vehicle Monitoring & Communications	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 min.	*				*	*																		
		> 30 min.	*	L	I	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 min.	*				*	*	*	*																
		> 30 min.	*	L	I	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 min.	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 min.	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
Rental fleet monitoring and communications	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 min.	*				*	*																		
		> 30 min.	*	L	I	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 min.	*				*	*	*	*																
		> 30 min.	*	L	I	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 min.	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 min.	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*

TABLE 1: MARKETS AND SUPPLIERS
EMERGENCY SERVICES

			Satellite Systems								Terrestrial Voice & Data							Terrestrial Data								
				Little LEO			Big Leo	Geo-synch																		
Emergency Services	***Coverage***	***Outages***	Leo One USA	Orbcomm	Starsys	VITA	Big Leo Systems	Inmarsat	AMSC (Skycell)	Omnitracs	Highwaymaster	VHF Radio Systems/WaterComm	Cellular	Broadband PCS	SMR	Geotek	NexTel	Ram Mobile Data	Ardis	CellNet	Metricom	CDPD	Cellemetry	Pinpoint Comm.	Nexus Tele.	Narrowband PCS
Search and Rescue	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 min.	*				*	*																		
		> 30 min.	*	L	I	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 min.	*				*	*	*	*																
		> 30 min.	*	L	I	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 min.	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 min.	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*

TABLE 1: MARKETS AND SUPPLIERS

MESSAGING

Messaging	Coverage	Outages	Satellite Systems: Little LEO: Leo One USA	Little LEO: Orbcomm	Little LEO: Starsys	Little LEO: VITA	Big Leo: Big Leo Systems	Geo-synch: Inmarsat	Geo-synch: AMSC (Skycell)	Geo-synch: Omnitracs	Terrestrial Voice & Data: Highwaymaster	Terrestrial Voice & Data: VHF Radio Systems/WaterComm	Terrestrial Voice & Data: Cellular	Terrestrial Voice & Data: Broadband PCS	Terrestrial Voice & Data: SMR	Terrestrial Voice & Data: Geotek	Terrestrial Voice & Data: NexTel	Terrestrial Data: Ram Mobile Data	Terrestrial Data: Ardis	Terrestrial Data: CellNet	Terrestrial Data: Metricom	Terrestrial Data: CDPD	Terrestrial Data: Celemetry	Terrestrial Data: Pinpoint Comm.	Terrestrial Data: Nexus Tele.	Terrestrial Data: Narrowband PCS
Messaging (paging and short e-mail)	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min.	*	L	I	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min.	*	L	I	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
Mobile workers (sales and service)	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min.	*	L	I	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min.	*	L	I	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
Information services (stock quotes, news, sports)	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min.	*	L	I	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min.	*	L	I	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*

TABLE 1: MARKETS AND SUPPLIERS
TRANSACTION SERVICES

			Satellite Systems								Terrestrial Voice & Data							Terrestrial Data								
				Little LEO			Big Leo	Geo-synch																		
Transaction Business Services	***Coverage***	***Outages***	Leo One USA	Orbcomm	Starsys	VITA	Big Leo Systems	Inmarsat	AMSC (Skyceli)	Omnitracs	Highwaymaster	VHF Radio Systems/WaterComm	Cellular	Broadband PCS	SMR	Geotek	NexTel	Ram Mobile Data	Ardis	CellNet	Metricom	CDPD	Cellemetry	Pinpoint Comm.	Nexus Tele.	Narrowband PCS
DTH Television return path	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min.	*	L	I	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min.	*	L	I	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
POS/ATM temporary and remote locations	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 5 min.	*				*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 5 min.	*				*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 5 min.	*				*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 5 min.	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
World health information delivery	Global	< 2 minutes	I				m/h	H																		
		> 2 min. & < 30 mi	*				*	*																		
		> 30 min.	*	L	I	I	*	*	Hc	Hc																
	Nationwide: Ubiquitous	< 2 minutes	I				m/h	H	H	H																
		> 2 min. & < 30 mi	*				*	*	*	*																
		> 30 min.	*	L	I	I	*	*	*	*	Hc		Lc	Lc			Mc	Mc	Mc							
	Nationwide: non-Ubiquitous	< 2 minutes	I				m/h	H	H	H	H		L	L			M	M	M							
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*			*	*	*							
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	Lc	Mc	*	*	*	Lc	Lc	Mc		Ic		Ic
	Urban / Pockets of Coverage	< 2 minutes	I				m/h	H	H	H	H		L	L	L	M	M	M	M	L	L	M		I		I
		> 2 min. & < 30 mi	*				*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*
		> 30 min.	*	L	I	I	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		*		*

12/96

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Director, Economic Policy Office, Antitrust Division, U.S. Department of Justice, Washington, D.C.; September 1983 - September 1985.

Research Associate, Center for the Study of American Business, Washington University in St. Louis; July 1978 - June 1985.

Associate Professor, Department of Economics, Washington University in St. Louis; July 1978 - June 1985. Chairman, Graduate Committee, 1978 - 1980. Chairman, Undergraduate Committee, 1980 - 1983.

Assistant Professor, Department of Economics, Washington University in St. Louis; September 1972 - June 1978.

Assistant in Instruction, Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, N.J.; 1969 - 1971.

Research Consultant, Ford Foundation, Kingston, Jamaica, W.I.; Summer 1969.

Fields Taught

Graduate: Industrial Organization, Economic Development and Planning, Microeconomic Theory, International Trade, International Finance, Economic Theories of Behavior, Applied Microeconomics.

Undergraduate: Government and Business, Industrial Organization, International Trade, International Finance, Economic Development, Intermediate Microeconomic Theory, Intermediate Macroeconomic Theory, Introductory Microeconomic Theory, Introductory Macroeconomic Theory.

Grants

National Science Foundation. Grant title: "Income Maximizing in Choice and Rate Effects," 1988 - 1991.

National Science Foundation. Grant title: "Application of Economic Theory to Operant Schedule Effects," 1985 - 1987.

National Science Foundation. Grant title: "Income and Choice," 1983 - 1985.

Professional Activities

Referee, *American Economic Review, The Bell Journal of Economics/Rand Journal, Economic Inquiry, Industrial Organization Review, Journal of Industrial Economics, Journal of Law and Economics, Journal of Political Economy, Quarterly Journal of Economics, Southern Economic Journal.*

Member, Editorial Board, *International Journal of the Economics of Business.*

Member, American Bar Association, American Economic Association, Southern Economic Association, Western Economic Association.

Languages

French, German

Publications

"Exclusionary Behavior in the Market for Operating System Software: the Case of Microsoft," in *Opening Networks to Competition: the Regulation and Pricing of Access*, David Gabel and David Weiman, eds.; Kluwer Publishers, 1996 (forthcoming), with Kenneth Baseman and Glenn Woroch.

"Riding the Wave: Exclusionary Practices in Markets for Microprocessors Used in IBM-Compatible Personal Computers," Conference and Festschrift in Honor of Merton J. Peck, Yale University, September 30, 1994, and *International Journal of the Economics of Business* 2-2 (July 1995), pp. 241-262, with Robert W. Wilson.

"The Economics of Intellectual Property Protection for Software: The Proper Role for Copyright," American Council on Interoperable Systems, Washington, D.C., June 1994, and *StandardView: ACM Perspectives on Standardization* 3-2 (June 1995), pp.68-78, with Kenneth Baseman and Glenn Woroch.

"Microsoft Plays Hardball: Use of Nonlinear Pricing and Technical Incompatibility to Exclude Rivals in the Market for Operating Software," *The Antitrust Bulletin* 40-2 (Summer 1995), pp.265-315, with Ken Baseman and Glenn Woroch.

"Copyright Protection of Software Can Make Economic Sense," *The Computer Lawyer*, 12 (February 1995), pp. 10, 18-28, with Kenneth C. Baseman and Glenn Woroch.

"Exclusionary Practices in High-Technology Industries," *The St. Louis Bar Journal*, 16 (Summer 1994), pp. 28-34.

"Monsanto v. Spray-Rite: Resale Price Maintenance Reexamined," in *The Antitrust Revolution: The Role of Economics*, John E. Kwoka and Lawrence J. White, eds.; Scott, Foresman and Company, Glenview, Illinois, second edition, 1994.

"A Commentary on the 1992 U.S. Merger Guidelines," *International Merger Law*, 22 (June 1992), pp. 14-19.

"The Use of Stock Market Returns in Antitrust Analysis of Mergers," *Review of Industrial Organization*, 7-1 (1992), pp. 1-11, and *Economic Analysis Group Discussion Paper #88-1*, January 1988, with Robert H. McGuckin and Peter Waldstein.

"Implications of U.S. Experience with Horizontal Mergers and Takeovers for Canadian Competition Policy," in *The Law and Economics of Competition Policy*, Frank Mathewson, Michael Trebilcock and Michael Walker, eds.; The Fraser Institute, Vancouver, B.C., 1990.

"Maricopa and Maximum-Price Agreements: Time for a New Legal Standard?" *Journal of Health Economics*, 7 (June 1988), pp. 185-190.

"Maximizing Present Value: A Model to Explain Why Moderate Response Rates Obtain on Variable-Interval Schedules," *Journal of the Experimental Analysis of Behavior*, 49 (May 1988), pp. 331-338, with Alan Silberberg and Toshio Asano.